Is this a proposal?

Proposed project: GPS Collar Purchase for Anderson Mesa Pronghorn Studies
Amount requested: $65,000
Requested by: Chasa O'Brien, WMRS
Project Lead: Steve Rosenstock, WMRS

The Anderson Mesa herd is one of the highest priority pronghorn populations in Arizona and the focus of Department research and management efforts for decades. In 2003, the Department initiated an extensive treatment program on Anderson Mesa to address habitat degradation caused by woodland expansion. With these efforts nearing completion, an important next step is assessing pronghorn responses to these treatments and identifying other habitat factors that may be important to conservation of this herd. We propose to purchase 16 satellite uplinking GPS collars that would be deployed in Fall 2009. Data from these collars will support a 2-year study of pronghorn movements and habitat use; a follow-up to the pre-treatment study currently underway (a collaborative effort between the Department's Research Branch and Northern Arizona University). This effort falls under 2 ongoing Federal Aid projects (Pronghorn Movements and Forest/Woodland Restoration).

HPC - RESEARCH PROPOSAL AND SCOPE OF WORK
State Route 64 Wildlife Accident Reduction Study Monitoring

by
Arizona Game and Fish Department
Research Branch

September 25, 2008

PROBLEM STATEMENT

Direct and indirect highway impacts have been characterized as some of the most prevalent and widespread forces altering natural ecosystems in the U.S. (Noss and Cooperrider 1994, Trombulak and Frissell 2000, Farrell et al. 2002). The direct impact of collisions with motor vehicles is a significant source of mortality affecting wildlife populations. An estimated 500,000 (Romin and Bissonette 1996*a*) to 700,000 (Schwabe and Schuhmann 2002) deer (*Odocoileus* spp.) alone are killed annually on U.S. highways. Wildlife-vehicle collisions cause human injuries and deaths, tremendous property damage and substantial loss of recreational opportunity and revenue associated with sport hunting (Reed et al. 1982, Schwabe and Schuhmann 2002), and disproportionately affect threatened or endangered species (Foster and Humphrey 1996). Numerous assessments of spatio-temporal patterns of WVC have been conducted, most focusing on deer (Reed and Woodard 1981, Bashore et al. 1985, Romin and Bissonette 1996*b*, Hubbard 2000). Only recently have assessments specifically addressed elk (*Cervus elaphus*)-vehicle collision patterns (Gunson and Clevenger 2003, Biggs et al. 2004, Dodd et al. 2006).

Forman and Alexander (1998) and Forman (2000) estimated that highways have affected >20% of the U.S. land area through habitat loss and degradation. Perhaps the most pervasive impact of highways on wildlife are barrier and fragmentation effects resulting in diminished habitat connectivity and permeability (Noss and Cooperrider 1994, Forman et al. 2003). Highways block animal movements between seasonal ranges or other vital habitats (Trombulak and Frissell 2000). This barrier effect fragments habitats and populations, reduces genetic interchange (Epps et al. 2005, Riley et al. 2006), and limits dispersal of young (Beier 1995), all serving to disrupt viable wildlife population processes. Long-term fragmentation and isolation renders populations more vulnerable to stochastic events that may lead to extinctions (Hanski and Gilpin 1997). Though numerous studies have alluded to highway barrier effects on wildlife (e.g., see Forman et al. 2003), few have yielded quantitative data relative to animal passage rates, particularly in an experimental (e.g., pre- and post-construction) context, as Dodd et al. (2007*a*) did for elk along State Route 260 in central Arizona.

Dodd et al. (2007*a*) used Global Positioning System (GPS) telemetry to find that elk passage rates averaged 0.88 crossings/approach on highway reconstruction control sections, 0.84 on sections under reconstruction, but dropped to 0.43 when the upgraded State Route 260 was completed and opened to traffic. Permeability documented for other wildlife species has been considerably lower, though Paquet and Callaghan (1996) reported that passage rates for wolves (*Canis lupus*) averaged 0.93 along a low-volume highway; however wolf passage rates averaged only 0.06 along the Trans-Canada Highway. Waller and Servheen (2005) compared grizzly bear (*Ursus arctos*) highway crossing frequency from GPS telemetry to simulated random walk analyses to assess permeability; observed bear crossing frequency was 31% of simulated. Dyer et al. (2002) compared actual road and simulated road network crossing rates; caribou (*Rangifer tarandus*) crossed actual roads <20% as frequently as simulated networks. Compared to these and other large mammal species, the barrier effect from highways appears to affect no species as much as it does pronghorn (*Antilocapra americana*); during extensive VHF-telemetry studies in northern Arizona, Ockenfels et al. (1994) and van Ripper and Ockenfels (1998) never documented a successful pronghorn crossing of a paved and fenced highway. The fragmentation of northern Arizona's pronghorn herds by highways has contributed to isolation of populations and prevention of seasonal migration, contributing to reduction of pronghorn populations (O'Gara and Yoakum 1992, Sawyer and Rudd 2005). With increasing human development and traffic volume on highways within pronghorn habitat that already constitute barriers to pronghorn movement (Ticer et al. 1999) pronghorn are a species of considerable concern.

Wildlife passage structures have shown tremendous benefit in promoting wildlife passage for a variety of wildlife species (Farrell et al. 2002, Clevenger and Waltho 2003), and in conjunction with fencing have reduced the incidence of wildlife-vehicle collisions (Clevenger et al. 2001, Dodd et al. 2006) and promoted both effective underpass use by wildlife and highway permeability (Dodd et al. 2007*b*). Dodd et al. (2007*b*) found that after fencing a section of highway, the incidence of elk collisions declined 87%. Before fencing, only 12% of deer and elk videotaped approaching underpasses successfully passed through; 81% of animals continued to cross the highway at grade. After fencing, 56% crossed successfully and no animals crossed the highway at grade. The probability of an approaching animal crossing through an UP increased from 0.09 to 0.56 with fencing, and the combined odds of a crossing through the UP after fencing was 13.6:1 compared to before fencing. Dodd et al. (2007*b*) further found that the elk highway passage rate after the highway was opened to traffic but before fencing was erected (0.54 crossings/approach) was 31.6% lower than the level determined from a previous study for the section during reconstruction (0.79). Once fencing was erected, the passage rate increased 52% (0.82). However, pronghorn remain a particularly difficult species for which to mitigate highway impacts. Yoakum (2004) believed that pronghorn behavioral characteristics might preclude effective use of both underpasses and overpass of high-volume highways. Sawyer and Rudd (2005) reported that "with the exception of Plumb et al. (2003) and several anecdotal observations, we could not find any published of documented information on pronghorn utilizing crossing structures". Still, they believed that large open-span bridged underpasses might be more effective in promoting pronghorn passage than overpasses, though no studies have been done to support this contention.

Dodd et at. (2007*a*, *b*) used GPS telemetry in an adaptive management context with ADOT reconstruction of State Route 260 to determine the extent of strategically-located ungulate proof fencing to intercept crossing elk. Such information could also be used to make data-driven decisions or refinements to decisions on the location of wildlife passage structures.

STATE ROUTE 64 WILDLIFE ACCIDENT REDUCTION STUDY

State Route (SR) 64 is the highway route connecting Williams/Interstate-40 to the Grand Canyon National Park. The incidence of wildlife-vehicle collisions (WVC) along the 50-mile stretch (MP 185.5–235.4) of highway between Interstate-40 and the community of Tusayan is a significant and growing concern. This predominately 2-lane highway will be reconstructed in the future to a 4-lane divided highway to address growing traffic volume and the incidence of WVC. To help address the WVC issue, ADOT commissioned the development of an assessment of WVC and potential mitigations to reduce their incidence along SR 64. The *Final Wildlife Accident Reduction Study* (JE Jacobs Consultants 2006) reported that 48% of 475 accidents recorded along SR 64 in the 5-year period between October 1, 1998–September 30, 2003 involved collisions with wildlife. This study developed and evaluated alternatives and associated mitigation measures that could be incorporated into the planned feasibility study for the reconstruction of SR 64. The *Final Wildlife Accident Reduction Study* broke SR 64 into five sections with two alternatives for three of the sections:

SR 64			Proposed wildlife mitigations			Focal
Section	Mileposts	Alternative	Underpass	Overpass	Fencing	wildlife species
A	185.5–204.7	A(W)-1	2[a]	0	Yes	Elk, mule deer
	(19.2 mi)	A(W)-2	1[a]	1	Yes	
B	204.7–212.5 (7.8 mi)	None	0	0	No	Pronghorn
C	212.5–214.3 (1.8 mi)	None	0	0	No	None - human development
D	214.3–223.4	D(W)-1	1	0	Yes	Elk, mule deer
	(9.1 mi)	D(W)-2	0	1	Yes	
E	223.4–235.4	E(W)-1	4	0	Yes	Elk, mule deer
	(12.0 mi)	E(W)-2	4	1	Yes	

[a] Including the existing Cataract Canyon Bridge which will be used as a passage structure

The proactive *Final Wildlife Accident Reduction Study* identified the need to conduct further field evaluation and monitoring to obtain additional information to determine the best locations for wildlife passage structures, and to determine the extent of fencing needed to funnel animals to passage structures. The report indicated that the focus of such monitoring should be between milepost 222.0 and 235.4 (Sections D and E, above), where the highest incidence of wildlife-vehicle collisions has occurred in the past involving elk and mule deer (*O. heminious*). The report also called for the monitoring of current and potential (e.g., with added funnel fencing) wildlife use of the existing Cataract Canyon Bridge (milepost 187.3; Section A) to determine whether its multiple box culvert design is conducive to wildlife passage. Lastly, the report addressed the potential barrier effect to pronghorn (especially along Section B) and recommended that this issue also be further addressed with monitoring. The *Final Wildlife Accident Reduction Study* recommended that a cooperative research project between ADOT and Arizona Game and Fish Department be initiated in advance of final design for highway reconstruction such that the refined, site specific information can be incorporated into the final reconstruction plans. This research project scope of work addresses such a research project.

RESEARCH OBJECTIVES AND PROCEDURES

This research project will both add considerably to our understanding of wildlife movements in relation to highways and provide information to support data-driven design planning for the planned reconstruction of SR 64. The specific research objectives and associated procedures of this research project include:

1) Assess elk highway crossing patterns, and distribution relative to SR 64 and determine permeability across the highway corridor,

2) Investigate the relationships of elk, highway crossing and distribution patterns to vehicular traffic volume along SR 64,

3) Develop recommendations to enhance elk highway permeability though the application of wildlife passage structures and ungulate-proof fencing.

Objective 1. Assess elk movements, highway crossing patterns, and distribution relative to SR 64 and determine permeability across the State Route 64 highway corridor.

This is the primary objective of this research project and we will rely on the application of GPS telemetry. We will employ methodologies developed and reported by Dodd et al. (2007*a*, 2007*c*) to assess movements, distribution, and measure elk permeability. To collect the most data with available funding we will use SOB collars that will be recovered after 22 months of data collection.

Task 1.1. Instrument elk with GPS receiver collars.

Task 1.1.1. In the first year of the project, the research team will instrument an additional 20 elk with new store-on-board GPS receiver collars along SR 64. Collars will be installed on elk as close as possible to the highway corridor (preferably within ½ mile of the highway), and distributed as evenly as possible along the length of SR 64 between mileposts 222.0 and 235.4, the area of peaks in elk collisions with vehicles documented in the *Final Wildlife Accident Reduction Study*. Elk will primarily be captured using Clover traps, along with limited darting and use of a drop net. As elk are generally crepuscular/nocturnal in their habits, GPS collars will be programmed to receive 8 fixes/day between 1600–0800 hours (1 fix every 120 minutes). This time interval between fixes is also sufficient to determine highway crossings (Dodd et al. 2006*a*) and assess relationships to traffic volume (Gagnon 2006, see Objective 2). Operational battery life of these collars is projected to be approximately 22 months, and should yield >5,000 GPS fixes/animal.

Task 1.4. Use Geographic Information System (GIS) analysis to determine elk, mule deer, and pronghorn movements, highway crossing patterns, distribution relative to the highway, and to assess permeability across the highway corridor.

Task 1.4.1. GPS data will be downloaded to a computer after collars drop from elk, mule deer, and pronghorn on pre-programmed release dates. After downloading, GPS data will be analyzed by GIS using ArcGIS and Animal Movement ArcView Extension software (Dodd et al. 2006*a*).

Task 1.4.2. To determine the frequency of crossings by elk, mule deer, and pronghorn, the length of the study section of highway will be delineated into sequentially numbered 0.10-mile segments. Crossings will be determined where successive GPS fixes occur on each side of the highway, with the crossing segment determined to be the one in which the line between the successive fixes falls. To assess highway permeability, the research team will utilize the same approach as Dodd et al. (2006*a*) to measure passage rates by elk, deer, and pronghorn. Passage rate, as a measure of permeability, is determined from the ratio of highway crossings to approaches. An approach is considered to have occurred when an animal travels toward the highway and enters the 0.15-mile buffer zone; it ultimately may cross or repel from the highway.

Objective 2. Investigate the spatial and temporal relationships of elk, mule deer, and pronghorn highway crossing and distribution patterns to vehicular traffic volume.

Gagnon (2006) addressed the relationships of elk distribution and highway crossings to traffic volume along SR 260, with traffic affecting both animal distribution and timing of crossings of elk accessing preferred foraging areas adjacent to SR 260 (Manzo 2006) Recent theoretical models (Mueller and Berthoud 1997, Iuell et al. 2003, Jaeger et al. 2005) assume that the potential for traffic to act as an impermeable moving fence (Bellis and Graves 1978) increases with traffic volume, although this theoretical model has yet to be tested for elk along a high traffic volume highway, which is ongoing along Interstate-17 south of Flagstaff (17,500 AADT).

We have been cooperating with ADOT's Traffic Planning Division in installing permanent traffic counters along several northern Arizona highways where wildlife telemetry studies are ongoing, including SR 260, U.S. Highway 89, and Interstate-17 (traffic counter to be installed on April 24-25, 2006). A permanent (automatic traffic recorder – ATR) traffic counter already exists along SR 64 near Williams and a second system should be installed by April 15, 2007 between Tusayan and the entrance to Grand Canyon National Park. Traffic data (number of vehicles, average speed, and vehicle types) are being recorded in 1-hour intervals. The AADT (2005) for SR 64 ranges from 5,200 near Williams to 7,900 at the entrance to the Grand Canyon National Park.

Task 2.1. Assess the relationship between traffic volume and elk distribution and crossing patterns.

Task 2.1.1. Assess the relationship between traffic volume and elk distribution and crossing patterns, using the same approach as Gagnon (2006). Both elk highway crossing and distance from the highway will be linked to average traffic volumes for the GPS fix interval period. Relationships between traffic volume and elk movements will be assessed using logistic regression, as per Gagnon (2006).

Task 2.3.1. Under a separate research project anticipated to be funded in the future, conduct assessments of noise and sound properties along SR 64 at various traffic volumes (supported by the traffic count data that will be collected), distances from the highway corridor, terrain characteristics, and time. This information will be utilized in a logistic regression model to assess relationships to elk, mule deer, and pronghorn movements and distribution. Similar data will be collected along other highways where wildlife-highway relationships research is ongoing or will begin in the near future, including SR 260 (GPS data for elk and white-tailed deer), Interstate-17 (elk), and U.S. Highway 89 (pronghorn).

Objective 6. Develop recommendations to enhance elk, mule deer and pronghorn highway permeability though the application of wildlife passage structures and ungulate-proof fencing.

Task 6.1. Using all data and information, develop recommendations on the specific location and need (e.g., all 4 SR 64 Section E passages my not be needed) for passage structures and other mitigations (e.g., funnel fencing) to promote elk permeability across SR 64. Such recommendations will assess the trade-offs associated with underpasses, overpasses, and other options to promote permeability including the role of fencing, etc. Though we do not anticipate documenting a large number of pronghorn crossings of SR 64 (especially compared with the nearly 6,000 crossings determined for elk along SR 260; Dodd et al. 2007*b*), the data nonetheless will proved invaluable in assessing and developing recommendations on those locations where highway passage structures may promote permeability (Sawyer and Rudd 2005).

PROJECT DELIVERABLES AND SCHEDULE

This research project will run concurrent with the ongoing ATRC funded research project along SR 64. The schedule for submission or accomplishment of project deliverables is detailed below:

Project Deliverable	**Completion date(s)**
Project Status Reports	October 5, 2007; January 5, April 5, July 5, October 5, 2008; January 5, April 5, July 5, October 5, 2009; January 2010
Final Project Report	March 2010
Onsite project implementation guidance	Ongoing throughout duration of project
Scientific journal manuscripts	Various during and after the project
Professional/scientific symposia presentations	Various during and after the project

PROJECT BUDGET

Supplemental Store-on-Board elk GPS Collars = $42,000.00

PROJECT CONTACTS

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